

Puerto Rico Space Grant Consortium
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PROGRAM DESCRIPTION

The National Space Grant College and Fellowship Program consists of 52 state-based, university-led Space Grant Consortia in each of the 50 states plus the District of Columbia and the Commonwealth of Puerto Rico. Annually, each consortium receives funds to develop and implement student fellowships and scholarships programs; interdisciplinary space-related research infrastructure, education, and public service programs; and cooperative initiatives with industry, research laboratories, and state, local, and other governments. Space Grant operates at the intersection of NASA's interest as implemented by alignment with the Mission Directorates and the state's interests. Although it is primarily a higher education program, Space Grant programs encompass the entire length of the education pipeline, including elementary/secondary and informal education. The **Puerto Rico Space Grant** Consortium is a Designated Grant Consortium funded at a level of **\$845,000** for fiscal year 2010.

PROGRAM GOALS

Goal: Increase the number of students pursuing undergraduate and graduate studies in STEM areas.

- Provide fellowships and scholarships to STEM students participating in projects pertinent to NASA
- Strengthen existing graduate programs by sponsoring research travel and internships at NASA centers for students and faculty
- Provide research experiences to STEM undergraduates at four-year colleges

Goal: Enhance PR's research capability and infrastructure in areas relevant to NASA

- Provide seed grants in areas relevant to NASA as evidenced by collaborations with NASA as evidenced by collaborations with NASA centers
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Goal: Infuse pre-college education with exciting STEM activities to increase students' interest in STEM careers

- Provide a range of professional development workshops for in-service and pre-service teachers

- Promote the incorporation of NASA-related science topics and content in the pre-college classrooms through teacher workshops that make use of NASA content and NASA educational materials
- Provide an intensive two-week STEM summer camp to outstanding pre-college students

Goal: Disseminate exciting information about NASA to the general community to build support for the enhancement of STEM education and research

- Involve mass media in the dissemination of news about NASA accomplishments and NASA spinoffs that enhance our quality of life.
- Support the training of pre-service teachers as general public educators through internships at science museums and similar facilities

PROGRAM BENEFIT TO OUTCOME 1

- a. Students that participated in PRSGC's hands-on hardware CubeSat Project were hired in STEM positions, as follows:
 - Christian Núñez - mechanical engineer at NASA Kennedy Space Center
 - Ludwig López - software engineer at Honeywell Aerospace
 - Francisco Rivera - research engineer at the National Astronomy and Ionosphere Center
- b. The research project of Lisandra Arroyo, *Microgravity Effect on Molecular Diffusion in Nanoporous Materials*, was selected by NASA's Reduced Gravity Education Flight Program of NASA Johnson Space Center. Ms. Arroyo is a chemistry doctoral student at the University of Puerto Rico and a Space Grant Fellow. As a result of this achievement, she will have the opportunity to test and evaluate her experiment aboard a microgravity aircraft, which flies about 30 roller-coaster-like climbs and dips to produce periods of micro and hyper gravity, ranging from 0 g's to 2 g's. Her experiment will bring new knowledge about the diffusion of molecular species through nanoporous systems in microgravity conditions, which have critical implications for the development of new aerospace technologies based on nanomaterials, such as rechargeable batteries, fuel cells, and wastewater purification systems.
- c. Teams supported by PRSGC took the top awards in the college and high school divisions of the 18th Annual Great Moonbuggy Race. For the second time in two years, the University of Puerto Rico at Humacao team won the first place in the college division. The Teodoro Aguilar Mora Vocational High School Team II of Yabucoa, Puerto Rico, won first place in the high school division. Team I from Teodoro Aguilar Mora Vocational High School in Yabucoa, Puerto Rico, won the second-place trophy in the race. The event was organized by NASA Marshall Space Flight Center, and held on April 1-2, 2011, at the Space and Rocket Center in Huntsville. This NASA competition challenges students around the world to build and race a lightweight, human-powered buggy. As a result, the students tackled many of the same engineering challenges dealt with by NASA engineers, thus gaining technical knowledge relevant to NASA and becoming better prepared to lead a

successful career in STEM. More than 70 teams from 23 U.S. Jurisdictions, Canada, Germany, India and Russia took part in the race.

PROGRAM BENEFIT TO OUTCOME 2

NASA Advancing the Future through STEM Educator's Forum was held on April 11, 2011 at UPR-Mayagüez with the participation of NASA Glenn Research Center, NASA Kennedy Space Center and NASA Goddard Space Flight Center. The workshops were conducted by:

- Mr. Ray Lugo, Director of NASA Glenn Research Center
- Astronaut Michael Foreman, NASA Glenn Research Center, Chief of External Programs
- Astronaut José Hernández, retired astronaut of Hispanic heritage
- Mrs. Marjorie Marcy, Aerospace Education, NASA Glenn Research Center
- Mr. Miguel Rodríguez, Director of Engineering, Technology and Administration, NASA Kennedy Space Center
- Dr. Lester Morales, Educators' Resource Center Specialist, NASA Kennedy Space Center
- Mrs. Lina Rosado, Educators' Resource Center Specialist, NASA Kennedy Space Center
- Mrs. Susan Koehler, Aerospace Education Services Specialist, NASA Goddard Space Flight Center

The Forum's objective was to present effective learning strategies directed to enhance students' academic progress by establishing linkages of collaboration between the academia and various NASA Centers that promote academic excellence in STEM. A total of 200 teachers of the STEM disciplines from all around the Jurisdiction participated in this event.

PROGRAM BENEFIT TO OUTCOME 3

Astronauts José Hernández (STS-128) and Michael Foreman (STS-123, STS-129) visited Puerto Rico for a whole week in November 14-19, 2010 to give presentations at different places around the Island. They captured the attention of the press and the general public, making their visit a huge success in terms of outreach impact. They were main speakers at large venues, such as the Yagüez Theater in Mayagüez, and the Univision Amphitheater in Guaynabo. They also gave conferences at main pre-college education sites, such as the PR Aerospace Lab in Arecibo and StarBase-PR in Carolina, and served as judges in the PR Robotics Competition. Moreover, they were received by the PR Governor of PR, Luis Fortuño, interviewed by TV talk shows and radio interview programs, and reviewed by the Jurisdiction's written press on a daily basis. Through this visit, Astronauts Hernández and Foreman reached the general public across the Jurisdiction and conveyed the message that education is essential in order to succeed in life, and that NASA welcomes students from all socio-economic levels and races to join

its excellent workforce. This high-impact activity was done in partnership with NASA Glenn Research Center.

PROGRAM ACCOMPLISHMENTS

- **Outcome 1:** *Contribute to the development of the STEM workforce in disciplines needed to achieve NASA's strategic goals*
 - a. **Fellowships/Scholarships Program:** PRSGC provided full support (stipend and tuition) to 17 students during the 2010-2011 academic year: 12 PhD students, 2 MS students, and 3 BS. The recipient students participated in NASA-related projects developed by researchers in the Jurisdiction in collaboration with NASA centers. The participating projects include topics in: Astrophysics, Astrochemistry, Electrochemistry, Bioremediation, Nanotechnology, Photovoltaic Cells, Fuel Cells, Materials Science, Catalysts, Biosensors, and Atmospheric Aerosols. The collaborating research centers include: Glenn Research Center, Kennedy Space Center, Langley Research Center, Goddard Space Flight Center, Johnson Space Center, Ames Research Center, Institute for Functional Nanomaterials, Center for Advanced Nanoscale Materials, and Jet Propulsion Lab.
 - b. **Research Internships Program:** PRSGC supported 14 students in research internships during FY 2010. The host research centers include: Glenn Research Center, Kennedy Space Center, Langley Research Center, Goddard Space Flight Center, Johnson Space Center, Ames Research center, Jet Propulsion Lab, University of California at Berkeley, Connecticut Center for Advanced Technology, Institute for Functional Nanomaterials, and Center for Advanced Nanoscale Materials. Projects supported through the Internship Program include these topics: Small Satellite Development and Building, Development of Fuel Cells and Rechargeable Batteries, Management and Mitigation Strategies of Water Resources, Study of Solvent Effects on Materials Wearing, Development of Nanomaterials for Sensor Applications.
 - c. **Research Infrastructure Development Projects:** PRSGC supported 6 research seed projects relevant to NASA in collaboration with NASA centers. A total of 6 faculty members and 8 research students participated in these projects. The seed projects involved the participation of 4 affiliate member institutions: University of Puerto Rico at Mayagüez, University of Puerto Rico at Río Piedras, University of Puerto Rico at Bayamón, Univeristy of Puerto Rico Humacao. The following institutions collaborated in the research seed projects: NASA Marshall Space Flight Center, NASA Langley, NASA Goddard Space Flight Center NASA Glenn Research Center , Univeristy of California at Berkley, Boston University, University of Central Florida, Virginia Space Grant Consortium, Florida Space Grant Consortium. The research infrastructure projects were done in collaboration with NASA centers on the following subjects: Computational

Materials Science, Nanomaterials or Aerospace Applications, New Energy Conversion Materials, Fabrication of Aerogels for Insulation Applications, Solid Oxide Fuel Cell Electrolyte Materials, Satellite Engineering, and Bringing Research into the Classroom.

- **Outcome 2:** *Attract and retain students in STEM disciplines through a progression of educational opportunities for students, teachers, and faculty*
 - a. Hardware Projects for Undergraduate Students: PRSGC supported 11 hands-on hardware projects that involved 200 students and 14 faculty members. They were developed by 5 different affiliate institutions: University of Puerto Rico at Río Piedras, University of Puerto Rico at Humacao, Interamerican University of Puerto Rico, Ana G. Méndez University System, University of Puerto Rico at Bayamón. The participating affiliate institutions received expertise and support from: NASA Goddard Space Flight Center, NASA Marshall Space Flight Center, NASA Wallops Flight Facility, National Undergraduate Research Observatory, and the University of California at Berkeley. The Higher Education projects included: Solar All-terrain Vehicle, Earth Science Terrain Station, Solar MiniCart Competition, Aero Design Competition, A satellite engineering course using the CubeSat platform, Two meteorology instrumentation courses using the RockSat platform, The Great Moonbuggy Race. By participating in these projects, the students gained technical knowledge relevant to NASA and became better prepared to lead a successful career in STEM.
 - b. Pre-service Teacher Experience: PRSGC supported 3 pre-service STEM teachers to obtain an innovative teaching experience at STARBASE Puerto Rico. STARBASE is a premier educational program, sponsored by the Office of the Assistant Secretary of Defense for Reserve Affairs. At STARBASE students participate in challenging "hands-on, mind-on" activities in Science, Technology, Engineering, and Math (STEM). The program provides students with 20-25 hours of stimulating experiences. STARBASE Puerto Rico became a place to provide premier teaching experiences to pre-service teachers a part of their training to become teachers prepared to educate the highly skilled American workforce that can meet the advanced technological requirements of our Nation.
 - c. Experimental Astronomy Research Experience for Undergraduate Students: PRSGC supported 10 students to do research at the National Undergraduate Research Observatory (NURO). NURO is a consortium of primarily undergraduate education institutions from around the country, both public and private, that have joined together to provide training and research experiences for their students. Together they share 120 nights per year on Lowell Observatory's 31-inch telescope, with instrumentation and observer support provided by Northern Arizona University through its Department of Physics and Astronomy. Astronomers and students at the member schools collaborate on key research projects through NURO.

- d. Summer STEM Academy: PRSGC selected 20 high school rising juniors to participate in the Summer STEM Academy in June 2011. A total of 63 applications were received; 10 females and 10 male students were selected. The Summer STEM Academy is a two-week on-campus residential experience developed to provide rising seniors with: a) first-hand interactions with NASA and university scientists and engineers, and STEM college students who will serve as positive role models and mentors; and b) activities designed to refine their study skills and enhance their awareness of NASA projects and careers in order to empower them with the necessary tools to achieve their full potential and inspire them to pursue STEM careers. The NASA Digital Learning Network will be vital in providing the tools to educate, engage and empower the students to refine their science, math and research skills, motivating them through videoconferences that provide direct interactions with NASA Centers' scientists.
- e. Pre-College Projects: A range of training activities were implemented in order to provide the in-service teachers, pre-service teachers, and pre-college students with NASA content and NASA educational materials. A total of 63 projects were carried out that involved 13 affiliate institutions: UPR-Mayaguez, UPR-Río Piedras, UPR-Humacao, UPR-Arecibo, UPR-Carolina, Ana G. Méndez System, Interamerican University, Polytechnic University of PR, PR NASA Explorer School, Arecibo Observatory, PR Department of Education, Univision-PR, StarBase-PR. The activities also involved the participation of non-affiliate organizations participating: NASA Goddard Space Flight Center, NASA Kennedy Space Center, NOAA, PR Department of Education, Municipality of Guaynabo, PR Seismic Web, PR Emergency Management Office. College faculty and students help organize the pre-college activities, exert leadership in their implementation, and also become participants who benefit from the activity.

Direct Participants of Pre-College Projects:

- In-service Educators: 824
- Pre-service Educators: 14
- Informal Educators/Museum Staff: 2
- Precollege Students: 1,026
- Administrators: 11
- Parents/Guardians: 87
- Higher Education Students (non- Pre-service): 52
- Higher Education Faculty: 33
- Public At Large: 6,200
- Other Adult: 171
- Total Direct Participants: 8,420

Outcome 3: *Build strategic partnerships and linkages between STEM formal and informal education providers that promote STEM literacy and awareness of NASA's mission*

- Informal Education Projects: A range of educational projects targeted at the general public were implemented in order to bring NASA science and technology into the

realm of the commonly heard of and spoken about topics in PR with the purpose of: (a) planting the idea of pursuing STEM careers in children and youngsters and (b) increasing the overall societal esteem for STEM career paths, so that adults provide positive feedback to young people who express interest in STEM careers. The Informal Education Projects included astronauts' presentations, astronomy observations for the community, conferences open to the public, and demonstration/information booths in malls. A total of 36 projects were carried out that involved 8 affiliate institutions: PR Astronomy Society, Univision-PR, UPR-Río Piedras, UPR-Mayagüez, UPR-Bayamón, Interamerican University of PR, Polytechnic University of PR, PR NASA Explorer School. The activities also involved the participation of NASA centers and non-affiliate organizations participating: NASA Kennedy Space Center, NASA Goddard Space Flight Center, Chicago Museum of Science and Industry, National Oceanic and Atmospheric Administration PR Office, PR Department of Education, Municipality of Guaynabo, Puerto Rico Seismic Web, PR Emergency Management Office.

Distribution of Informal Education Projects:

- 7 informal education resources/materials were developed.
- 6 exhibits were supported/developed.
- 8 student hands-on activities were implemented.
- 15 public-at-large activities were carried out.

Direct Participants of Informal Education Projects:

- In-service Educators: 582
- Pre-service Educators: 30
- Informal Educators/Museum Staff: 4
- Precollege Students: 7,912
- Administrators: 28
- Parents/Guardians: 105
- Higher Education Students (non- Pre-service): 301
- Higher Education Faculty: 53
- Public At Large: 120,000 estimated
- Total Direct Participants: 129,015

PROGRAM CONTRIBUTIONS TO PART MEASURES

- Longitudinal Tracking:
 - a) Total awards = 194 (all Hispanic U.S. citizens)
 - b) Fellowship/Scholarship = 17
 - c) Higher Education/Research Infrastructure = 177
 - d) 161(91%) of students had successful academic progress and continue in academia
 - e) 33 students graduated in STEM fields
 - f) 91% of graduates are employed in STEM
 - g) 10 students have accepted STEM positions in an aerospace industry or NASA
 - h) 20 students have accepted STEM positions in academia
- Course Development: 1 (Satellite Engineering at Interamerican University of PR)
- Minority-Serving Institutions: 11
The PRSGC network of affiliates includes eleven minority-serving institutions: two research-intensive public universities (one in the southwest and one in the northeast), five public four-year universities (two in the northeast, one in the southeast, one in the north, and one in the central region), three private four-year colleges (in the San Juan metropolitan area), and the lead institution. These minority-serving affiliate institutions are strategically located, covering all geographical regions and socio-economic levels across the Jurisdiction. They extend PRSGC's ability to prepare a "pipeline" of individuals committed to NASA's vision and mission.
- 5 Professional Development Workshops for Teachers (Long Duration, greater than or equal to 2 days in length) were provided. 85% of educators who participated in long-duration NASA training programs used NASA resources in their classroom instruction.
- 43 Professional Development Workshops for Teachers (Short Duration, less than 2 days in length) were provided. 70% of educators who participated in short-duration NASA education activities used NASA resources in their classroom instruction.
- 13 short-duration student-based projects were supported that involved 1,026 elementary and secondary students. 90% of students expressed interest in STEM careers following their involvement in NASA elementary and secondary education programs.
- 1 long-duration (2-week) student-based project was supported. It involved 20 secondary student participants in NASA instructional and enrichment activities. 100% of these students expressed interest in STEM careers.
- Matching Funds: \$845,000 (1:1 ratio)
 - a) \$ 760,000 in cash, provided by the University of Puerto Rico Central Administration
 - b) \$ 90,000 in-kind, provided by the affiliate institutions

IMPROVEMENTS MADE IN THE PAST YEAR

PRSGC has given priority to undergraduate research experiences and hands-on hardware projects during FY2010. Projects that fall in these categories are particularly effective for preparing the students to achieve high goals, such as working in the aerospace industry and completing advanced STEM degrees.

PROGRAM PARTNERS AND ROLE OF PARTNERS IN PROJECT EXECUTION

- UPR-Central Administration: lead institution and Jurisdiction-level management
- UPR-Mayagüez: undergraduate research, graduate research, in-service teacher training, pre-service teacher training, pre-college education, outreach projects
- UPR-Río Piedras: hardware projects, undergraduate research, graduate research, in-service teacher training, pre-college education, outreach projects
- UPR-Humacao: hardware projects, undergraduate research, in-service teacher training, pre-service teacher training, pre-college education, outreach projects
- UPR-Cayey: undergraduate research, in-service teacher training, pre-college education, outreach projects
- UPR-Arecibo: hardware projects, in-service teacher training, pre-service teacher training, pre-college education, outreach projects
- UPR-Carolina: undergraduate research, pre-college education, outreach projects
- UPR-Bayamón: hardware projects, undergraduate research, pre-college education, outreach projects
- Ana G. Méndez University System: hardware projects, in-service teacher training, pre-college education, outreach projects
- Interamerican University of PR: hardware projects, undergraduate research, in-service teacher training, pre-college education, outreach projects
- Polytechnic University of PR: hardware projects, undergraduate research, in-service teacher training, pre-college education, outreach projects
- PR NASA Explorer School: hardware projects, in-service teacher training, pre-college education, outreach projects
- National Astronomy and Ionosphere Center: undergraduate research, graduate research, in-service teacher training, pre-college education, outreach projects
- PR Department of Education: in-service teacher training, pre-service teacher training, pre-college education, outreach projects
- Univision-PR: undergraduate research, in-service teacher training, pre-service teacher training, pre-college education, outreach projects
- StarBase-PR: in-service teacher training, pre-service teacher training, pre-college education